PASSENGER STATION AND TERMINAL DESIGN FOR SAFETY, SECURITY AND RESILIENCE TO TERRORIST ATTACK

Project nº: FP7-SCPO-GA-2011-266202
Funding Scheme: CP – Collaborative Project
Call (part) identifier: FP7-SST-2010-RTD-1

D.7.3 – GAP ANALYSIS FOR CURRENT STANDARDS AND GUIDELINES

Due date of deliverable: 30/11/2013 **Actual submission date:** 31/01/2014

Start date of project: 01/06/2011 **Duration:** 36 months

Organisation name of lead for this deliverable: USFD

Revision: 1.0

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Document Change Log				
Revision	**Edition Date**	**Author**	**Modified Sections / Pages**	**Comments**
0.1	28.11.2013	USFD - Emma Carter	All	Structure
0.2	05.12.2013	USFD - Emma Carter	Ch.1, 2, 3 & 4	Main content
0.3	17.12.2013	InteCo - Rodica Hrin ISDEFE - Marga Sanchez ATM – Anna Romano	Ch. 3 & 4	Contributions on existing risk assessment and station design guidelines from author's country
0.4	15.01.2014	ISDEFE – Marga Sanchez	Ch.1, 2 & 3	Proof-reading
0.5	27.01.2014	MTRS - Gilad Rafaeli DAPP - Stefano Porziani CRTM - Tomas Melero USFD - Jon Paragreen	Ch. 3 & 5	Sections describing original contributions of Work Packages 3, 5 and 6
1.0	30.01.2014	USFD – Emma Carter	Ch. 6 & 7	Analysis of results from operator questionnaires and gap analysis summary.

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List of acronyms and abbreviations

APTA	American Public Transportation Association (USA)
ATOC	Association of Train Operating Companies (UK)
AVB	Anti-Vehicle Barriers
BSI	British Standards Institution
BTP	British Transport Police
CBR	Chemical Biological or Radiological
CCTV	Closed Circuit Television
CFPA	Confederation of Fire Protection Associations (EU)
CNPIC	National Centre for the Protection of Critical Infrastructure (Spain)
CPNI	Centre for the Protection of National Infrastructure (UK)
CPTED	Crime Prevention Through Environmental Design
CTSA	Counter Terrorism Security Assessors (UK)
DfT	Department for Transport (UK)
DHS	Department of Homeland Security (USA)
DoT	Department of Transportation (USA)
FEMA	Federal Emergency Management Agency (USA)
FTA	Federal Transit Administration (USA)
HVAC	Heating, Ventilation and Air-Conditioning
HVM	Hostile Vehicle Mitigation
IED	Improvised Explosive Device
IPCT-SA	Institute of design, research and construction computing (Romania)
IM	Infrastructure Manager
ISO	International Organization for Standardization
MTI	Mineta Transportation Institute (USA)
NaCTSO	National Counter Terrorism Security Office (UK)
NIBS	National Institute of Building Sciences (USA)
NFPA	National Fire Protection Association (USA)
NRC	National Research Council (USA)
NYPD	New York Police Department (USA)
PA	Public Address system
PBIED	Person-Borne Improvised Explosive Device
PIH	Poison Inhalation Hazard
PTA	Public Transport Authority
PTO	Public Transport Operator
RAM	Risk Assessment Methodology
RIBA	Royal Institute of British Architects
SECURE-ED	Secured Urban Transportation – European Demonstration (EU)
SEST-RAM	SECURESTATION Risk Assessment Methodology (EU)
VBIED	Vehicle-Borne Improvised Explosive Device
WP	Work Package

1. Introduction

1.1. Background

The SECURESTATION project has the overall aim of improving passenger station and terminal resilience to terrorist attacks and safety incidents through technologies and methodologies enabling design to reduce the impact of blast, fire, and the dispersion of toxic agents on passengers, staff and infrastructure.

The project will achieve this aim through the following objectives:

- Increase resilience of passenger stations and terminals through structural design, interior design and building services design, providing everyday benefits while designing for security
- Ensure cost-effectiveness of countermeasures through the application of risk analysis methodologies to prioritise any action taken towards the design and operation of passenger stations and terminals.
- Deliver a Constructive Design Handbook addressing new build and retro-fit cases to serve as a useful decision support tool for owners and operators to increase station security and safety from terrorist bomb blast, toxic material dispersion and fire events
- Create harmonisation and the standardisation of risk assessment methodologies, security technologies and design solutions in order to support widespread application by the numerous EC public transport organisations and associated key stakeholders.

Terrorist attacks using explosives or toxic materials represent a significant global risk due to the increase in religious and national radical movements that use such tactics. European authorities, industries, operators, builders, architects, and technology developers must work together to develop a common European approach for strengthening resilience to these attacks. The railway network is a particularly vulnerable target due to being an open system with free circulation of passengers and goods and open-access buildings. The SECURESTATION project aims to provide specific guidance for increasing the resilience of rail transportation and intermodal transport infrastructure across Europe.

1.2. Purpose and Scope

The purpose of this deliverable is to compare the results of other work packages with existing research and currently available regulations, standards and guidelines on risk assessment and design for CT security. The Work Packages included in this report are WP3 (Risk assessment), WP4 (Constructive design handbook), WP5 (Predictive tool for physical and functional resilience) and WP6 (Simulation of pedestrian behaviour and movement in emergencies). For each of these a summary will be given with an emphasis on the new contribution to the field and a comparison with other related research or public guidance. The operator feedback will help identify where current practice is already meeting the aim of designing for resilience and conversely where new guidelines are needed. It will also provide recommendations on the implementation of the SECURESTATION results, as well a description of future activities needed to cover any gaps or limitations identified. To fulfil this objective several consultation processes have been activated through structured interviews and questionnaires.

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1.3. Document Structure

The following inputs are been used in this analysis:

- D3.2 – Risk Assessment Methodology.
- D4.3 – Constructive Design Handbook.
- D5.3 – Design strategies to improve the safety and security from both the physical and functional perspective.
- D6.4 – Design strategies from the operational point of view to optimize evacuation procedures.
- Review of existing guidelines available in the public domain.
- Results from PTO and IM questionnaire regarding their current use of guidelines and standards and their opinion on where more guidance is needed.

Chapter 1 - Introduction

Chapter 2 - Existing guidelines and standards – summary of the guidance currently available and the range of security issues addressed

Chapter 3 - Risk Assessment – a summary and unique contribution of SECURESTATION WP3 which has developed a Risk Assessment Methodology together with a review of existing guidance and standards on Risk Assessment from various national and international sources.

Chapter 4 - Design guidelines – a summary of the SECURESTATION Design Handbook and a review of existing relevant design guidelines and standards in the public domain from various national and international sources.

Chapter 5 – Contribution of WP5 and WP6 (modelling of blast, fire and toxic material dispersion and)

Chapter 6 - Stakeholder response – results from European operator questionnaires: response on current use of guidelines and opinion on guidance not currently available and guidance which would be useful

Chapter 7 - Gap analysis

- Summary of gap between existing / used guidelines and standards and SECURESTATION outputs
- Summary of potential remaining gap between SECURESTATION outputs and ideal guidance for PTOs, IMs, engineers and architects

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2. Existing guidelines and standards

2.1. Introduction

There are many current regulations, guidelines and standards which give guidance or required standards for one or many of the issues relevant to design for resilience against terrorist attack in the context of public transport stations and interchanges. Some of the guidance documents have been written specifically for transportation but not specifically addressing counter-terrorism (e.g. 'National rail and underground CCTV guidance document'), whereas others were specific to counter-terrorism but not restricted to transport (e.g. 'Crowded Places: Design and Technical Issues'). Others were neither directly aimed at transportation nor specifically addressing counter-terrorism but were still deemed relevant documents as they are related to either the prevention or consequences of possible attacks (e.g. 'EU Standards for Fire detection and fire alarm systems'). Some of the publications emphasised the importance of co-operation and continued communication between architects, security specialists, structural engineers, trauma medics, search and rescue professionals and epidemiologists in order to continually improve survivability in the event of a terrorist attack [1].

2.2. Issues addressed in current guidelines

Counter-terrorism issues relating to public transport hubs can be grouped under the following topics: Different documents address some of all of the issues listed in varying levels of detail. References for some examples of documents addressing each topic are given – this list is not comprehensive):

- Risk assessment [2-16]
- Structural resilience to explosions, blast resistant building materials [3, 4, 14, 17-22]
- Building layout, architecture [3, 4, 14, 18, 22-25]
- Lighting [22, 26-28]
- VBIED prevention and mitigation including architecture and perimeter security [3, 4, 14, 15, 22, 29-31]
- Building access control including passenger and baggage screening [3, 4, 14-16, 22]
- CCTV surveillance [3, 4, 14, 22, 32-35]
- Staff training and procedures [1, 20, 22]
- PIH / CBR attack prevention and mitigation including HVAC system design [3, 14, 20, 22, 36]
- Fire prevention and mitigation [2, 3, 22, 27, 37-39]
- Emergency exits & general accessibility [3, 4, 11, 14, 22, 26, 39]

2.3. Source and availability of current guidelines

The guidelines and standards reviewed here came from a number of sources including government agencies (e.g. CPNI, NaCTSO, BSI and CNPIC) various organisations in the USA (e.g. FEMA, FTA, NFPA), European and International regulatory bodies and associations (e.g. ISO and EN standards) and some other national standards and association (e.g. the Romanian IPCT-SA).
Many of the high level guidance documents are public domain and freely available to download from the internet. EU, ISO and BSI standards are public domain but must be purchased. More detailed guidance on security risk assessment, blast resilience and other counter-terrorism measures are confidential due to the sensitive nature of this information. Most of the public domain guidance documents reviewed in detail in this document are those which are available in English.

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3. Risk Assessment guidelines

3.1. Introduction

Risk can be defined as the potential of an action or situation to result in a certain level of loss, damage or injury. Risk assessments therefore attempt to quantify the relative risk of an activity by multiplying the probability of an undesirable event by the severity of the potential consequences. For example, the risk of climbing a ladder is the product of the probability of falling off the ladder and the severity of the potential injury. In the context of counter-terrorism, risk is defined as the product of three factors: the probability of an attack, the probability of the attack succeeding (or vulnerability) and the resulting consequences (or impact of that attack).

Risk = [relative probability of attack] x [probability of attack succeeding] x [consequences of attack] **Eq.1**

Each of these factors can then be scored according to a prescribed system with varying degrees of complexity and subjectivity, giving a semi-quantitative estimation of relative risk. This is most accurate when carried out for a particular threat (e.g. VBIED attack) at a particular station or terminal.

Consequences can include both direct and indirect fatalities, injuries and damage to property as well as less tangible losses such as public trust and in the case of public transport systems falling numbers of passengers.

Management of risk is the process of minimising and controlling the risks associated with security incidents. The main methods of control include:

- Reduce the likelihood of an attack
- Increase the probability of an attack being detected and neutralised
- Reduce the impact of an attack

There is a lot of guidance available on the risk assessment process in general which can be applied to any place or activity. There is also more specific information related to fire risk assessment. General guidance on risk assessment and generic risk assessment tools are freely available and no threat to national security. However, access to more detailed risk assessment methodologies (e.g. including specific information on the vulnerability of certain features of station design), should be controlled. For this reason, the SEST-RAM is classed as 'EU-Confidential'.

3.2. SECURE STATION Risk Assessment Methodology

D3.2 of WP3 presents the SECURESTATION Risk Assessment Methodology (SEST-RAM), developed to enable PTOs and IMs to carry out in-depth semi-quantitative risk assessments on their stations and terminals.

The document consists of four main parts:

1. Brief description of the risk assessment process according to ISO 31000 including the inputs and outputs of each step of the process (8 pages)
2. Detailed 44 page description of the SEST-RAM including definitions of the chosen threat scenarios and a comprehensive guide to the 2-step risk assessment process:

   i. Step 1: Identification of risks and existing security arrangements
   ii. Step 2: Quantification of risk as a factor of threat, vulnerability and consequences (see Eq.1)
3. Discussion of the computer models used to estimate the consequences of blast, PIH, fire and smoke to people and property (26 pages)
4. Guide to assessing the residual risk following the implementation of risk mitigation measures (13 pages)

Scope: Terrorist threats to EU public transport stations and terminals (rail and interchange)
Depth: Very detailed
RAM: Detailed semi-quantitative
Language: English

SEST-RAM is unique in several aspects, when compared with other methodologies (e.g. SECUR-ED, COUNTERACT, EUMAS, Sandia's RAM). These aspects are as follows:

- It focuses on transport terminals, while enabling the expansion of the model to also include other public transport infrastructures (rolling stock, tunnels, bridges, maintenance depots and stabling areas);
- A comprehensive mathematical model is provided to assess the probability of attack and the vulnerability, including alternate options for the quantification of certain parameters;
- Integrating with and complementary to the simulation methods, including the models used by the partners and the work done by D'Appolonia on functional resilience modelling.
- Assessment of the residual risk following the implementation of safeguards – policies, methods, trained manpower, procedures, physical means and protection technologies.

In addition to the methodology itself, which is a written document (a report), a set of Excel spreadsheets was developed within the framework of the project. The spreadsheets translates the quantitative methodology into a practical tool that can be used to conduct risk assessments in passenger terminals, based on the definition of assets, scenarios and inputs from the specific or generic simulations of blasts, dispersion of PIH, fire and smoke. The tool has been successfully demonstrated for a generic interchange station and is available to the partners for research work, but it is not in the form of ready-to-use package for generic third parties. The developed set of spreadsheets also includes the generation of an extensive series of diverse graphs which demonstrate how the results may be presented for technical discussions and for decision making.

3.3. Existing Guidance on Risk Assessment

Several examples of existing public domain guidance on risk assessment are summarised in this section. They range from very simple introductory booklets to extensive manuals on the subject of counter-terrorism risk assessment. The documents are grouped according to the national or international affiliation of their source.

3.3.1. EU

CFPA European Guideline: *'Introduction to qualitative fire risk assessment'*
This document offers a reasonably thorough explanation of the risk assessment procedure relating specifically to fire risk. It uses a very simple risk formula: [Risk = Hazard x Exposure], where the Hazard is either 0 or 1 and Exposure is rated on a scale of 1 – 3. Presence of flammable materials is given as an example. A detailed risk assessment form containing a comprehensive set of questions for fire risk is included.
Scope: Fire risk to buildings (European Union)
Depth: Introductory explanation
RAM: Very simple, brief, semi-quantitative
Language: English

SECURE-ED: D31.4 SRS - Risk Assessment Tool
Software tool for the security risk assessment of European urban transportation (not public domain)
Public summary available: http://www.secur-ed.eu/wp-content/uploads/2013/07/SECUR-ED.EU_D31.4_Risk_Assessment_Tool_SRS_Public_Summary.pdf

3.3.2. UK

Official guidance on terrorism risk assessment in the UK is generally of a high-level, introductory nature, and often refers to the Counter Terrorism Security Assessors (CTASs), part of the Police force, as being the appropriate personnel to carry out risk assessments on buildings and crowded places deemed at medium to high risk.

NaCTSO: *'Counting the cost – Managing risk, insurance and terrorism'*
This is a brief, high level, qualitative guide to risk assessment of terrorist threats in crowded places produced by the UK Government and aimed at businesses in general. It includes some introductory guidance on recognising threats and hazards and a final section on insurance.
Scope: Terrorist threat to commercial buildings (UK)
Depth: Brief introduction
RAM: Simple qualitative
Language: English

NaCTSO: *' Expecting the unexpected - Business continuity in an uncertain world'*
This is a brief, very high level, qualitative guide to terrorist risk assessment, risk management, emergency procedures and resilience for businesses.
Scope: Terrorist threat to businesses (UK)
Depth: High level overview
RAM: None
Language: English

NaCTSO: *'Working together to protect crowded places' 2010*
This is a high level document produced by the UK Government addressing counter-terrorism in any crowded places in the UK. Chapter 3 and Annex A briefly describe the risk assessment process and 'crowded places risk matrix' developed in conjunction with several risk and security specialist bodies and used by the Police CTSAs to identify the relative risk of various crowded places. For those rated medium to high risk, the CTSA would assess the location / building's vulnerability and make recommendations for

improving their security. This document talks about how the CTSAs would carry out the risk assessment rather that a guide to self-assessment.
This process is also referred to in the following documents:

- UK Government 'Crowded Places: The planning system and counter-terrorism' 2012 [40]
- 'RIBA guidance on designing for counter-terrorism' [23]

For businesses and crowded places that are not prioritised for assessment by the CTSAs, NaCTSO offer an online vulnerability self-assessment tool for identifying vulnerabilities and potential security improvements.
Scope: Terrorist threats to crowded places (UK)
Depth: Very brief, high level guidance / summary
RAM: Semi-quantitative risk assessment matrix carried out by CTSAs
Language: English

UK Home Office: *'National Risk Register of Civil Emergencies'* 2012
This document summarises the current level of all kinds of civil emergency risk including a section on malicious attacks (i.e. terrorism). It includes very brief, high level summaries of current threat level, background and current planning for the following: attacks in crowded places; attacks against infrastructure; attacks against transport systems and 'unconventional attacks'.
Scope: General terrorist threats to the UK
Depth: Brief, high level summary of threat level /risk of terrorist attack
RAM: Only summarises the general risk of terrorist attack
Language: English

CPNI – *'Protecting against terrorism'*
This relatively high-level document advises on risk assessment and briefly describes the basic principles involved in formulating a semi-quantitative risk assessment.
Scope: Terrorist threats to any organisation (UK)
Depth: Very brief
RAM: Brief description of semi-quantitative RAM
Language: English

3.3.3. Spain

CNPIC – *'Guide to risk assessment'*
In Spain, there is a joint initiative, where Operators/IMs, the Spanish Ministry of Home Affairs and the Spanish National Center for Critical Infrastructure Protection (CNPIC) have defined the Sectorial Strategic Plans (PES), where a list of sectors have been identified as critical (e.g. transportation systems). Currently, work is focused on the elaboration of specific security plans for those facilities, systems and infrastructure assets classified as critical.
Up to date, it has been established the minimum contents for the creation of the operator security plan (OSP) and specific protection plans (PPE) to be elaborated by each critical operator. The minimal contents of these plans have been established following the Law 8/2011 (establishing the measures for the critical infrastructure protection) and the decree 704/2011 (which approves the regulations for the critical infrastructure protection):

- Resolution 15th November 2011 of the Spanish Security State Secretariat
- Resolution 29th November 2011 of the Spanish Security Secretariat

The OSP describes current best practice in risk assessment and bibliographical references as a tool to support CI operators in conducting their own risk assessments. There are a multitude of references related to security issues to guide the operators/infrastructure managers of CI, according to their specific needs; e.g. Standards ISO/IEC 20000 Information technology -- Service management ISO/IEC 13335 IT security management, ISO/IEC 28000 Specification for security management systems for the supply chain, ISO/PAS 22399 Societal security - Guideline for incident preparedness and operational continuity management. ISO 31000 Risk management — Principles and guidelines, etc.

Scope: Spanish infrastructure systems identified as critical (e.g. transport)
Depth: High level
RAM: Qualitative
Language Spanish

3.3.4. Romania

IPCT-SA – '*Guide to fire risk assessment and fire safety in crowded places'*, 2001
A guide to fire risk assessment and fire safety in crowded places was prepared by the Institute of design, research and construction computing (IPCT-SA) and approved by the Ministry of Construction and Transport (Order no. 1613) in 2001. The object of guide was to describe fire risk, prevention and mitigation factors and ascribe them relative values in order to estimate risk using a semi-quantitative methodology. The guide is used for fire risk assessment in existing public buildings and crowded places and for considering fire safety at the design stage.
Scope: Existing and new public buildings and crowded places (Romania)
Depth: Detailed
RAM: Semi-quantitative
Language: Romanian

3.3.5. International

ISO 31000:2009, '*Risk management – Principles and guidelines'*
This international standard offers general principles and a generic framework for assessing risk for any organization or activity and aims to establish the principles necessary for effective risk management. It does not refer to any particular risk category but can be applied to any industry to assess hazards applicable to them. It does not intend to promote a standardized risk management system for all organizations to adopt but emphasises that the response plans and risk management structure must take into account the specific needs of that organization according to their objectives, processes, structure, products or services.

ISO Guide 73:2009, '*Risk management – Vocabulary'*
This document provides definitions of the basic vocabulary used in risk management. The aim is to develop common understanding on risk management concepts and terms among organizations and functions, and across different applications and types. ISO 31000 (cited above) specifically refers to terms used in this Guide.

ISO/IEC 31010:2009, '*Risk management – Risk assessment techniques'*
This International Standard is a supporting standard for ISO 31000 and provides guidance on selection and application of systematic techniques for risk assessment. The application of a range of techniques is introduced, with specific references to other international standards where the concept and application of

techniques are described in greater detail. It doesn't provide specific criteria for identifying the need for risk analysis, or specify the type of risk analysis method that is required for a particular application.

3.3.6. USA

The USA, mainly the department of Homeland Security, have published some excellent, comprehensive documents on the subject of counter-terrorism in urban environments since 9/11, with one being devoted entirely to risk assessment. The guidance on risk assessment is sufficiently in-depth to equip non-specialist engineers and architects etc. to carry out their own risk assessments.

FEMA 426: *'Reference manual to mitigate potential terrorist attacks against buildings'* 2003
FEMA published a large, extremely comprehensive manual in 2003 (and again in 2011 - see below) on the mitigation of terrorist attacks on non-residential, civilian buildings. The manual begins with a substantial chapter on risk assessment entitled 'Asset value, threat/hazard, vulnerability and risk'.
The chapter presents selected methodologies to integrate information on threat, asset value and vulnerability which is then used for determining relative levels of risk. It gives a detailed qualitative guide to assessing threat level, asset value, vulnerability and risk. The chapter also provides a substantial, highly detailed table containing questions for assessing the vulnerability of a building and corresponding guidance (based upon current technologies and scientific research) to consider during the design of a new building or renovation of an existing building.
Scope: Terrorist threats to non-residential, civil buildings (USA)
Depth: Very detailed
RAM: Simple semi-quantitative
Language: English

FEMA 426: *'Reference manual to mitigate potential terrorist attacks against buildings'* 2011 [3]
Chapter 1 in the 2011 edition is entitled 'Threat, consequences, vulnerability and risk' and gives an overview to the whole risk assessment process. It includes a section on threat and hazard identification, details on terrorist attack event scenarios, a brief guide on evaluating vulnerability and qualifying potential losses. It then refers to another document (FEMA 452) for a more detailed description of the semi-quantitative risk assessment. It also includes a large, illustrated section outlining architectural, structural and other design characteristics that are either beneficial or harmful under various hazardous events (either terrorist attack or force of nature).
Scope: Terrorist threats to non-residential, civil buildings (USA)
Depth: Very detailed
RAM: Refers to semi-quantitative methodology detailed in FEMA 452
Language: English

FEMA 452: *'Risk Assessment - A How-To Guide to Mitigate Potential Terrorist Attacks Against Buildings'* 2005 [5]
This is an entire document devoted to risk assessment structured around the five step risk assessment process. It includes the detailed vulnerability checklist table which was previously found in the 2003 edition of FEMA 426. It is referred to in other security related guidance including several APTA security standards.
Scope: Terrorist threats to building (USA)
Depth: Extremely detailed (over 200 pages)
RAM: Detailed semi-quantitative
Language: English

NYPD: *'Engineering Security – Protective design for high risk buildings'* 2009 [4]
This is a very thorough document, written for terrorist threats to the New York built environment in particular giving it an emphasis on high rise buildings.
Chapter 2 describes the 'NYPD risk tiering system' which is based around the risk equation (Eq.1). Each of the three elements (defined here as threat, vulnerability and impact) are divided into sub-elements which are briefly described in this chapter.
Appendix A goes into more detail, giving scales for each sub-element providing a semi-quantitative risk assessment methodology. This more detailed treatment is again specifically aimed at terrorist threats to NYC (multi-storey buildings of varying architectural or national significance in a densely populated urban environment).
Scope: Terrorist threats to multi-storey business environment (USA)
Depth: Brief but very detailed
RAM: Simple semi-quantitative
Language: English

4. Design and security guidelines

4.1. Introduction

There are many ways in which a new station can be designed to reduce risks associated with terrorist attacks. Some of these are achieved through adherence to regular construction and fire safety regulations and some require specialist design strategies and security measures. The topics that could be considered relevant to counter-terrorism design and security are outlined in section 2.2 together with references to current examples of documents giving relatively thorough information on that particular topic.

Existing guidelines address one or more of the following features or topics:

- site layout design and perimeter security;
- architecture, layout and structural design of the building envelope;
- glazing and other building materials;
- building systems (HVAC, utilities, communications);
- safety and security systems (e.g. fire detection and extinguishing, alarms)
- access, egress and emergency evacuation;
- retrofit solutions to blast mitigation

Existing guidelines which specifically address terrorism mainly take account of the following threats:

- CBR attack / toxic material release
- blast (PBIED, VBIED)
- arson / IID

4.2. SECURE STATION Design Handbook

The SECURESTATION Constructive Design Handbook is intended to be used by two main groups:

- PTOs, PTAs and IMs
- engineers, architects and designers

The scope of the design handbook is for European rail and transport interchange stations and terminals to mitigate various terrorist threats including blast, fire and toxic material dispersion. The guidance is based partly on simulation work done looking the behaviour and effects of blast, fire and gas dispersion using a generic model of a typical European interchange. Simulations have also been carried out on crowd behaviour to inform design guidelines on effective evacuation and rescue.
The structure of the handbook is as follows:

1. Introductory section
2. Design strategies
3. Risk identification and mitigation
   - Risk assessment methodology
   - Background on relevant terrorist threats
4. Design guidelines
   - Site design
   - Architectural design and structural engineering
   - Security and safety systems

The handbook is presented graphically and users can either select an area of the station (this will link to guidance on relevant threats and corresponding design issues for that area) or they can select a certain threat (this will link to guidance on design issues to be considered throughout the station with respect to that particular threat).

4.3. Existing design guidelines

Although a substantial wealth of knowledge on counter-terrorism has existed for some time, particularly in the UK and Spain as a result of experiences with the IRA and ETA respectively, most guidance on counter-terrorism design and security has historically been restricted to police and military personnel. However, since the 2001 terrorist attacks in New York, there has been a significant increase in public domain guidance on the design of new buildings and retrofitting of existing ones to reduce the risk, vulnerability or consequences of terrorist attacks. These vary greatly in their level of detail - some simply give a brief overview so that planners may be aware of some of the potential issues and where they might look for the appropriate specialist, whereas others provide in-depth technical guidance to be used by architects and structural engineers. Some are aimed at specific issues (e.g. fire safety or blast resistance), while others may focus on certain targets (e.g. high-rise buildings or transport systems).

4.3.1. EU

EU action plan on chemical, biological, radiological and nuclear security, 2009

SAVE-ME project - (System and Actions for VEhicles and transportation hubs to support disaster Mitigation and Evacuation) - research, guidance and tools for emergency evacuation in transport disasters http://www.save-me.eu/objectives

SECURE-ED project – Demonstration project for the security of European transportation systems focussing on risk assessment, training, procedures, video analytics, CBR sensors and cyber security http://www.secur-ed.eu/

CFPA-Europe Guidance is available on Lighting (CFPA-Europe No.5:2003), Arson (CFPA-Europe 01:2010/S) and Emergency exits (CFPA -Europe No.2:2007) [27, 38, 39]

This project has been carried out under a contract awarded by the European Commission

EU standards are available on the following:

Fire detection and fire alarm systems (EN 54 series)
Part 2: Control and indicating equipment (EN 54- 2+AC:2000 / A1:2007)
Part 3: Fire alarm devices - Sounders (EN 54-3:2002 / A1:2003)
Part 7: Smoke detectors - Point detectors using scattered light, transmitted light or ionization (EN 54-7:2002 / A2:2007)
Part 20: Aspirating smoke detectors (EN 54-20:2006)
Part 24: Components of voice alarm systems – Loudspeakers (EN 54-24:2008)

Fire-fighting systems
Sprinkler systems (EN 12259:2002)
Gas extinguishing systems (EN 12094:2004)

Building hardware
Emergency exit devices operated by a lever handle or push pad, for use on escape routes - Requirements and test methods (EN 179:2008)
Panic exit devices operated by a horizontal bar, for use on escape routes - Requirements and test methods (EN 1125:2008)
Emergency exit devices (EN 1125:2008 and EN 179:2008)
Bullet resistant doors, windows, shutters and blinds (EN 1522:2004 and EN 1523:2004)

Glass in buildings
Thermally toughened soda lime silicate safety glass - Part 2: Evaluation of conformity/Product standard (EN 12150-2:2004)
Chemically strengthened soda lime silicate glass - Part 2: Evaluation of conformity/Product standard (EN 12337-2:2004)
Thermally toughened borosilicate safety glass - Part 2: Evaluation of conformity/Product standard (EN 13024-2:2004)
Heat soaked thermally toughened soda lime silicate safety glass - Part 2: Evaluation of conformity/Product standard (EN 14179-2:2005)

4.3.2. UK

The Railways Act 1993 – Security regulations set by DfT (not public domain)

British Standards Institution
There are a huge number of standards and codes of practice available which relate to building construction and design and some security measures. Many British Standards have been superseded by European Standards, pre-fixed with BS EN…. These are all available to purchase from the BSI website and can be relatively expensive. A few examples are shown below:
BSI PAS 68:2010 Impact test specifications for vehicle security barriers
BSI PAS 69:2006 Guidance for the selection, installation and use of vehicle security barriers
BS EN 13541:2012 Security glazing in buildings - testing and classification of resistance against explosion pressure
BS 8110-1:1997 Design and construction of reinforced and pre-stressed concrete structures. Based on limit state design principles and used for most civil engineering and building structures. (Superseded by BS EN 1992-1-1:2004)
BS 5950-1:2000 Code of practice on structural use of steelwork in buildings (rolled and welded sections).
Scope: Building, security (UK)

Topics / threats: Structural engineering, construction, HVAC, security barriers, security glazing

RIBA guidance on designing for counter-terrorism [23]
Aimed at architects and planners, this document gives quite high level advice on the risk of terrorist attacks in the UK and explains the concept of proportionate response and gives a comprehensive list of organisations who can offer specialist advice on the subject in the UK. It then briefly describes various design issues and counter-measures including access control, CCTV, hostile vehicle mitigation, HVAC, stand-off distance and glazing. It also presents some case studies from the UK including a shopping centre and a pedestrianized street.
Scope: Built environment (UK)
Topics / threats: VBIED, access control, HVAC, glazing

'SIDOS' Security in Design of Stations Guide [21]
This is a high level document but contains useful guidance on counter-terrorism and crime prevention specifically related to rail stations and terminals. It covers site layout, perimeter security and hostile vehicle mitigation and building layout, architecture and lighting. It also gives some brief but important points on blast mitigation and building materials and structural design. As well as practical design advice, the guide gives relevant contact details and links for further advice.
Scope: Rail stations and terminals (UK)
Topics / threats: Physical security measures against terrorism and other crime

Arup Security Consulting – Overview of Blast Mitigation Design Measures: Structures and Facades [19]
This small but detailed document discusses the blast resilience of buildings conforming to British building codes (post 1968) and gives a fairly in-depth design approach for building structure to avoid building collapse. It then addresses facades, giving detailed design consideration for windows and frames and briefly for non-glazed cladding.
Scope: Buildings (UK)
Topics / threats: Blast mitigation / counter IED

'Re-Design' Resilient Design Tool for Counter-Terrorism, 2012
This is a recently published interactive PDF / web-based high level guidance on resilient building design and site layout for counter-terrorism. It includes two threat scenario examples: a shopping centre and transport interchange. The guide is well-illustrated with photographic examples and focuses on integrating resilient design with the environment and architectural setting. It also recommends designs which g to allow flexibility to respond to changing threats, accessibility and ease of maintenance. The guide also gives useful contacts, key stakeholders and outlines the key stages of a design project
Scope: Crowded places (UK)
Topics / threats: Counter-terrorism

CPNI - Integrated Security: A Public Realm Design Guide for Hostile Vehicle Mitigation
This is a highly-illustrated 70-page guide on design for hostile vehicle mitigation (HVM). This is a high-level booklet with illustrated guidance on design principles and methods for integrated hostile vehicle mitigation including traffic management (road layout) and vehicle security barriers. Examples of the integrated design approach given include water features, topography and levels, street furniture, seating, walls, fences and natural barriers.
Scope: Public places (UK)
Topics / threats: Hostile vehicle / VBIED mitigation

4.3.3. Spain

Spanish Technical Building Code (CTE): Safety & security in case of fire
Spanish Technical Building Code (CTE): Safety & security for utilization and accessibility
Decree 704/2001: Regulations for the protection of critical infrastructure
Decree 393/2007 and 1468/2008: Basic self-protection standard for organisations dedicated to activities that may result in emergency situations.

4.3.4. Italy

Italy has a number of national 'Decreto Ministeriale' (Ministerial Decrees) relating to fire safety, published in Italian:

Ministerial Decree 11.01.1988 (fire prevention in the underground network):
This decree gives regulations on: evacuation routes, protected paths, protected areas, emergency exits, emergency access to the tunnel for firefighters, reaction to fire and emergency systems.
It gives also some design criteria for:

- the construction of the stations (crowding, paths of displacement, protection of equipment and /or protected areas, structure, environment, signage)
- the construction of tunnels (emergency routes, structure, communication)
- technical station systems (heating systems, emergency systems, power cables)
- technical tunnel systems (emergency systems, smoke evacuation and ventilation system, installation of drainage and pumping, electrical systems)

Ministerial Decree 10.03.1998 (general criteria for fire safety and emergency management in the workplace):
Establishes, in compliance with another Legislative Decree (no. 626/94), the criteria for the assessment of the risks of fire in the workplace and indicates the measures of fire prevention and protection to be taken in order to reduce the occurrence of a fire and to limit the consequences if it occurs.

Ministerial Decree 07.01.2005 (technical and procedural rules for the classification and certification of portable fire extinguishers):
This updates the rules governing the procedures and techniques for classification and approval of portable fire extinguishers for fire prevention. The decree covers several topics, including the approval, use, obligations and responsibilities of the manufacturer,

Decree of the President of the Republic 151 01.08.2011 (proceedings relating to fire prevention):
This identifies the activities subject to fire prevention inspections and sets fire safety inspection criteria.
For safety equipment then there are also the UNI regulations that determine how to design, test and maintain various systems:

- UNI 671 parts 1-2-3: for fixed fire-extinguishing systems
- UNI 12845: related to sprinkler systems
- UNI 9994: prescribes the criteria for making the initial inspection, monitoring, periodic monitoring, scheduled maintenance and testing of fire extinguishers
- UNI 11224: related to initial inspection and maintenance of fire detection systems
- UNI 9795: specifies the criteria for the design, installation and operation of fixed automatic detection and fire alarms
- UNI 10779: relates to the design, installation and operation of networks of hydrants

4.3.5. Romania

Joint Order of the Ministry of Transport, Construction and Tourism and Ministry of Administration and Internal Affairs No. 1822/394 of 7.10. 2004 *'Regulations on the fire resistance of construction materials'*

Government Decisions (GD) for regulations on the quality and inspection of construction and technical expertise:
GD 766 of 1997 '*Regulations on the quality of construction*' – This contains regulations concerning Construction metrology; Construction management and quality assurance; Establishing the category of constructions; Monitoring of the behaviour in operation, early intervention and post-use of buildings; Technical approvals for products, processes and equipment in the building; Licensing and accreditation of testing laboratories for analysis and construction; Certification of conformity as to the quality of products used in construction

GD 273 / 1994 (amendment 940 / 2006) *'Regulations on the certification of building work and related installations'*

GD 925 / 1995 *'Regulations for quality inspection and technical expertise of projects and construction etc.'*

LAW no. 106 of 25 September 1996, on civil protection - Civil protection is part of the national defence and includes all measures taken and activities carried out in order to protect the population, material assets, cultural values and environment factors in case of war, terrorism or natural disasters.

There are several documents relating to railway station design, maintenance and management produced by the Ministry of Transport. Railway stations permanent authorization for technical operation is issued by AFER (the Romanian Railways Authority) through the Romanian Railway Safety Authority to the legal entities that own railway stations, thus certifying that the particular railway station for which the authorization has been issued meets the technical conditions required for a safe rail transport service. The permanent authorization is a document covering a 10- year period from the date of its issue, and is valid upon its validation by the Romanian Railway Safety Authority every 2 years.

Romania has also adopted a large number of EU standards as national standards for issues such as the design and use of fire safety systems, windows, doors and emergency exits in stations.

4.3.6. International

ISO (International Organization on Standardization) has produced several standards that are relevant to the issue of counter-terrorism (e.g. generic risk assessment and explosion resistant glazing). There is also a final report of the ISO advisory group on security. www.iso.org
ISO standards for explosion resistant security glass in buildings: ISO 16933:2007 and ISO 16934:2007

ASTM International (formally the American Society for Testing of Materials) produces standards, manual and journals on a variety of subjects including those related to security and counter-terrorism. These standards, guidelines and journal papers are available to purchase from www.astm.org. Some examples are given below:

ASTM F2248-12: 'Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass'
ASTM E2831 / E2831M-11: 'Standard Guide for Deployment of Blast Resistant Trash Receptacles in Crowded Places'

The International Code Council is a member-focused association which develops model codes and standards for the design and construction of safe, sustainable, affordable and resilient structures. It is mainly used in the USA. www.iccsafe.org

4.3.7. USA

The USA, mainly the department of Homeland Security, have published some excellent, comprehensive documents on the subject of counter-terrorism in urban environments since 9/11, with one being devoted entirely to risk assessment. The guidance on risk assessment is sufficiently in-depth to equip non-specialist engineers and architects etc. to carry out their own risk assessments.

NIBS 'Whole Building Design Guide' - 'Blast safety of the building envelope' [18]
This brief but very detailed report forms part of the 'National Institution of Building Sciences' (NIBS) Whole Building Design Guide and is aimed at structural and civil engineers and architects. It is therefore a very detailed report specifically addressing the mitigation of explosive effects on the building envelope. There is an initial description of the threat of explosive attacks and the effect they have on buildings with a couple of examples. It then goes into detail describing the design philosophy and methodology; site and architectural issues, construction materials, types of walls, frames and connections, fenestration (including glass, and framing), roof deign and considerations for foundations and basements. It also compares design for blast resilience with earthquake resilience.
Scope: Buildings (USA)
Topics covered: VBIED and PBIED mitigation, blast resilient design and materials, progressive collapse, walls, structural frames and connections, fenestration

MTI / USA DoT: 'Protecting Public Surface Transportation Against Terrorism and Serious Crime: Continuing Research on Best Security Practices' 2001 [20]
This lengthy report (over 100 pages) analyses case studies of past terrorist attacks in the UK, USA and Japan. It gives a background and detailed description of the attack and discusses the immediate response to the attack, consequences, lessons learned, issues raised and preventative strategies employed as a result.
Scope: Public surface transportation (various countries)
Topics covered: Terrorism (blast and CBR), consequences, emergency response

FEMA 426: *'Reference manual to mitigate potential terrorist attacks against buildings'* 2003 [41]
FEMA published a large (420 page), extremely comprehensive manual in 2003 (and again in 2011 - see below) on the mitigation of terrorist attacks on non-residential, civilian buildings. A large portion of this guidance is on risk assessment. The following four chapters cover: site design; building design; explosive blast theory and CBR mitigation.
Scope: Non-residential, civil buildings (USA)
Topics covered: Risk assessment (detailed), site layout, building design, VBIED, PBIED, CBR, building systems

FEMA 426: *'Reference manual to mitigate potential terrorist attacks against buildings'* 2011 [3]
This more recent edition gives less detail on risk assessment (referring to a separate document) and more detail on design guidance for security threats. It is extremely thorough in its explanations of design

principles and includes numerous examples and illustrations. Consequently it is very long at over 500 pages.
Scope: Non-residential, civil buildings (USA)
Topics: Risk assessment (brief), design process, VBIED, PBIED, CBR, building design and materials, building systems, site layout, windows/glass, access control, emergency exits, security systems

FEMA 430: Site and urban design for security [15]
This FEMA guide is slightly smaller than the previous ones mentioned and is focussed on perimeter security and site layout with regard to VBIED or 'hostile vehicle' mitigation. It again gives a lot of explanations, examples and illustrations.
Scope: Non-residential, civil buildings (USA)
Topics: VBIED mitigation, perimeter security, barriers, site layout, layers of defence, urban context

NYPD: *'Engineering Security – Protective design for high risk buildings'* 2009 [4]
This is a very thorough and comprehensive but high level document, written for terrorist threats to the New York built environment in particular giving it an emphasis on medium and high tier buildings. The document includes several case studies on terrorist attacks to illustrate design considerations. The guidance covers blast resistance, fire resistance, prevention of building collapse (including reference to different design methodologies for prevention of progressive collapse) and design for emergency evacuation. It also gives advice on VBIED mitigation through perimeter security and site layout and addresses HVAC design for CBR mitigation.
Scope: Buildings - esp. multi-storey, businesses (USA)
Topics covered: Fire resistance, blast mitigation, site layout, perimeter security, access control, progressive collapse, screening, monitoring, emergency evacuation, CBR threats and HVAC design.

FTA: *'Transit Security Design Considerations', 2004 [22]*
This large, very detailed document aims to provide security-oriented design considerations for bus and rail vehicles, and for transportation infrastructure. It is intended for PTOs and contractors to implement appropriate countermeasures for new constructions and the retrofitting of existing ones so is similar to the aims of the SECURE STATION handbook but also includes vehicles and goes into less detail in some areas and more detail in others. Most of the document is public domain but some of the details are restricted (e.g. table on blast charge and damage distance).
Scope: Public land transportation systems – vehicles and infrastructure (USA)
Topics covered: Security strategy; access control, lighting and perimeter security; structural engineering, architecture and layout; vehicles; communications systems.

APTA Standards Development Programme - Recommended Practice, 2010-2013 (USA)
All available at: http://www.apta.com/resources/standards/Pages/Security-Standards.aspx
The APTA Standards Development Programme have produced some recommended practice guidelines as part of the Transit Infrastructure Security Working Group covering perimeter security, lighting, CCTV and other security and design issues:

- The 'Security lighting for transit passengers' guide establishes recommended practices for security lighting systems for transit passenger facilities to enhance the security of people, operations, assets and infrastructure. It includes risk assessment; types and designs of lighting, recommended illumination levels for various locations, inspection and maintenance issues and a lighting system checklist. [28].
- The recommended practice' on anti-vehicle barriers (AVB) briefly describes anti-vehicle barriers for transit passenger facilities to enhance the security of people, operations, assets and infrastructure by

preventing or mitigating the effects of VBIED attack. A detailed table outlines the different types of vehicle barriers from concrete modular barriers to planters and metal bollards etc. [30]

- The 'Crime prevention through environmental design (CPTED) for transit facilities' document provides guidance the use of crime prevention through environmental design of transit facilities. [24]
- The recommended practice on physical security for public transit provides some background information on basic physical security. It offers a brief overview of physical security measures related to security lighting, fencing and gates, doors, windows and glazing, HVAC, utilities, perimeter roads and standoff distance. It includes details on the blast resistance of different types of glass [17]

Scope: Public land transportation systems (USA)
Topics covered: Lighting, VBIED mitigation, perimeter security, access control, building and site layout, natural surveillance.

APTA number	Document title / subject
APTA SS-SIS-RP-001-10	Security Lighting for Transit Passenger Facilities
APTA SS-SIS-RP-002-10	Security Lighting for Nonrevenue Transit Passenger Facilities
APTA SS-SIS-RP-003-10	Fencing Systems to Control Access to Transit Facilities
APTA SS-SIS-RP-004-10	Metal Fencing Systems to Control Access to Transit Facilities
APTA SS-SIS-RP-005-10	Gates to Control Access to Transit Facilities
APTA SS-SIS-RP-006-10	Ornamental Fencing Systems to Control Access to Transit Facilities
APTA SS-SIS-RP-007-10	Crime Prevention Through Environmental Design for Transit Facilities
APTA SS-SIS-RP-001-12	Anti-Vehicle Barriers for Public Transit
APTA SS-SIS-RP-XX-12	Security Program Considerations for Public Transit
APTA SS-SIS-RP-013-13	Physical Security for Public Transit
APTA SS-SIS-RP-002-08	CCTV coverage and field-of-view for passenger facilities
APTA IT-CCTV-RP-001-11	Transit related CCTV Systems

Table 4-1: APTA recommended practice relevant to station security

NFPA 130 (USA)

The National Fire Protection Association publishes a fire safety standard guide specifically for 'Fixed Guideway Transit and Passenger Rail Systems'. Although published in the USA, these are used by several other coutries [37].

5. Modelling: Contribution from WP5 and WP6

5.1. Fire and evacuation

WP6 initially developed a questionnaire for the purpose of gathering data on the geometry, dimensions, passenger numbers and functionalities of terminals and stations all over Europe. This information was then used to produce a generic 3D model that may be regarded as an 'average' or typical European station, taking account of the nature of a station as not only a transport infrastructure, but a complex group of land uses in a very specific geometry. This model has been used as the reference model for the different analytical simulations carried out as part of the SECURESTATION project. These include explosions, fire, toxic substance dispersion and evacuation.

In addition, this WP has carried out a thorough literature review of all the state of the art concerning fire and evacuation scenarios, identifying those technologies, procedures and standards which are most efficient for fire protection. WP6 has also revealed the importance of real tests in order to both validate simulation models and check the proper operation of facilities and protection systems in a real environment.

Probably the most important contribution by WP6 has been to demonstrate that the challenge of terrorist attacks in stations and terminals is a global issue in which protection cannot be separated from evacuation. SECURESTATION proposes that the issue is a four-element challenge in which all of the following elements are influenced by each other: threat (e.g. fire in the case of WP6), protection systems, evacuation and special events (e.g. presence of injured passengers, panic etc.). The global problem can only be solved by considering the existing interaction between these elements.

5.2. Chemical dispersion modelling (WP5)

Part of WP5 involved modelling the dispersion of toxic chemicals within the SECURESTATION model station environment and identifying the effect of different ventilation flow regimes, station geometry and the effect of trains arriving or departing, on the dispersion rates and ultimately the impact of such attacks. Within the publicly available literature, very little modelling of directly relevant material has been published. It is likely that confidential reports exist on modelling carried out by security agencies and military organisation to assess the potential impact of such chemical attacks but these are not available in the public domain. Within the public literature there is a Swedish conference paper [42] which describes the modelling of a sarin release in a metro train, with the release similar in size and dispersion method to the Tokyo attacks in 1995. This methodology was used as the basis for the some of the sarin and VX simulations within SECURESTATION which also used toxicity data to plot the levels of harm to passengers at different locations. However, SECURESTATION has enhanced this modelling methodology by including turbulence using parameters taken from the wealth of literature on the modelling of natural air flows, forced heating and ventilation and smoke simulations within buildings and large atria. There is also a substantial body of knowledge on modelling the dispersion of toxic industrial chemicals in the open environment, but much of the dispersion in these cases is dominated by the prevailing wind.

The toxic material modelling within SECURESTATION was expanded to different materials, including less toxic but more readily available industrial materials such as chlorine, ammonia and hydrogen cyanide, as well as sarin and VX agent. Different dispersion methods including vapour release, aerosol and vaporising pools of liquid were also considered. These simulations have been directly applicable to the scenarios defined in the project and have given numerical values which can be used define the impact of such an attack. The simulations have also confirmed various existing theories regarding ventilation. For

example they have supported the theory that lateral ventilation flows will have a greater impact in dispersing material more rapidly through the internal environment than ventilation which flows from floor to ceiling. It has also confirmed the potentially devastating impact of a nerve agent dispersed through the ventilation system. The simulations have also identified some unexpected phenomena: For example, the turbulent recirculation of air occurring at high extraction rates can have a negative impact on toxic material dispersion, thereby actually increasing the area of the station affected by a release.

5.3. Blast modelling (WP5)

Another part of WP5, carried out by D'Appolonia, relates to the simulation of terrorist bomb attacks, specifically the numerical reconstruction of the blast wave expansion for the identified blast scenarios. This was performed employing two methods characterized by increasing levels of complexity and reliability, commonly referred to as empirical and numerical methods respectively. In order to apply the empirical method, the relationships obtained by means of experimental measurements were incorporated into two in-house tools. These proprietary tools, which combine a good level of accuracy with an intuitive interface, enable rapid calculation of the main blast wave parameters of interest within the project.

As well as the empirical method, the more complex and accurate numerical model, or 'Finite Element Method' (FEM), was also used to model blast waves in stations. This complexity and accuracy can be increased further by using the numerical model to simulate the stresses in the structural elements themselves under the blast wave action (as well as the blast wave itself) in order to model their response and evaluate the resulting damage. It is worth remarking that this kind of analysis requires skilled modellers and significant computational time and resources to obtain accurate results. Use of state-of-the-art hardware and software tools and efficient modelling strategies will minimise computation time, but the simulation of structural element behaviour under blast attack still remains a demanding task. Consequently, this should only be carried out in the latest phases of the design or retrofitting process.

5.4. Equipment vulnerability modelling (WP5)

The second focus of D'Appolonia's work within SECURESTATION has been related to the definition of a methodology and systematic framework for evaluating the vulnerability and availability of a building's equipment. In this methodology, the equipment is modelled and the vulnerability and availability of components analysed and ranked in order of importance so that critical components can be identified. Using this analysis, the compromise between the financial investment to limit the vulnerability of equipment and the reduction in the consequences of its failure (functional, direct economic and those related to human life) has been presented as a decision making process based on economic and technical factors. The effects considered are those relating to the loss of elements and loss of equipment functionality. The ranking and selection of countermeasures are performed according to constraints indicated by the user (e.g. a limited budget under the ALARP approach, or a pre-determined level of enhancement of system resilience to be achieved).

A specific tool, 'SARA' (SECURESTATION Attack Resilience Assessment), has been developed to implement this methodology and has been applied to the generic station model created as part of WP5. The development of the tool and its application to a complex case study has served as verification of the methodology and supportive of its suitability for real-world cases.

These activities allowed D'Appolonia to apply techniques and experience developed within other fields of engineering (e.g. seismic events) to the enhancement of the functional resilience of stations to terrorist

attacks. Both the network approach to the modelling of equipment and the assessment of the station in terms of functional analysis, as well as the combination of these two methods, represent meaningful achievements which add to the existing knowledge in this field. As far as can be verified through review of the relevant literature, functional analysis of the station building, representation of equipment by means of the network approach and the combination of these two items, seem to be innovative ways to approach the equipment design of a station. This approach could be an interesting area of research for further activities aimed at adding detail to the methodology, applying it to more case studies and consolidating it into a practical design tool.

6. Survey of European PTOs and IMs

PTOs and IMs from across Europe were asked several questions relating their current use of guidelines and standards in risk assessment, design and other security related issues. A total of 12 sets of responses were gathered from 7 different countries either from a questionnaire or in the case of Romania from an interview based on the survey questions.

The first question asked if the PTO or IM currently used guidelines or standards in carrying out certain activities. Of the 10 PTOs and IMs from across Europe who responded to this question, all used guidelines for at least one of the security related activities listed and four of the respondents used guidelines for all activities (Table 6-1). The activities less likely to require guidance were 'Managing security' and 'Training personnel' (Figure 6-1).

Activity	UK (1)	UK (3)	Portugal	Denmark	Italy (1)	Italy (2)	Germany (1)	Germany (2)	Germany (3)	Spain
Carrying out risk assessments	Y	Y	Y	Y	-	Y	Y	Y	Y	Y
Deciding design criteria for new infrastructure	Y	Y	Y	Y	Y	-	-	Y	Y	Y
Designing new infrastructure	Y	Y	Y	Y	-	Y	Y	Y	Y	-
Re-designing or re-fitting existing infrastructure	Y	Y	Y	Y	-	Y	Y	Y	Y	-
Managing security	Y	Y	Y	Y	-	Y	Y	Y	Y	-
Developing security protocol	Y	Y	-	Y	-	-	-	Y	-	Y
Training personnel	Y	Y	-	Y	-	-	-	Y	-	-

Table 6-1: Activities for which PTOs / IMs use current guidelines

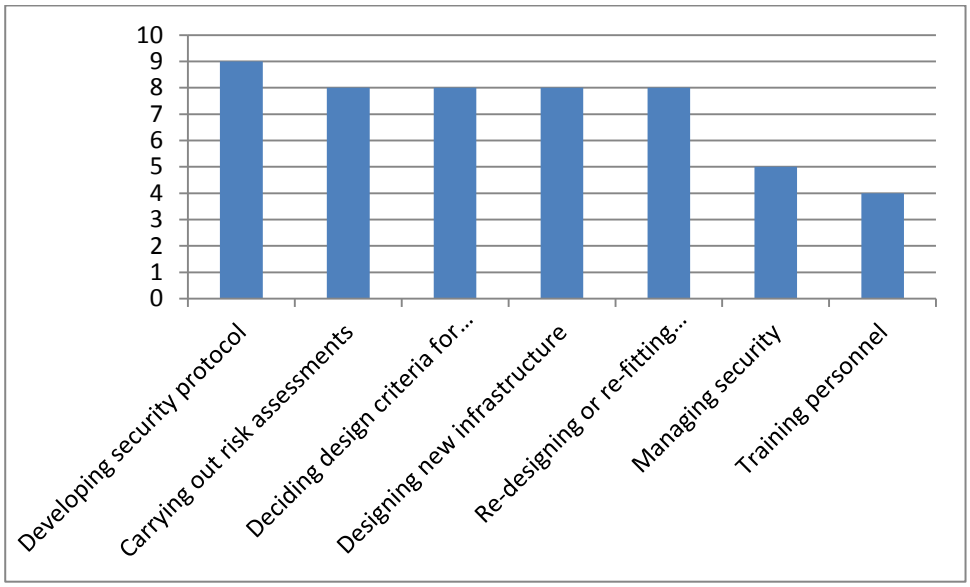

Figure 6-1: Activities for which PTOs / IMs use current guidelines

Next they were asked which sources of guidance they used and if they were some use or very useful with respect to security issues: Results are shown in Table 5-2 where S = "some use" and V = "very useful". They all used their own national or state guidelines and standards and most also used International guidance and to a lesser degree, European guidance. National guidelines were most likely to be considered 'very useful'. Three respondents also found guidance from the USA to be useful (Table 6-2 and Figure 6-2).

Sources of guidance on security issues used by PTOs and IMs	UK (1)	UK (2)	UK (3)	Portugal	Denmark	Italy (1)	Italy (2)	Romania	Germany (1)	Germany (2)	Germany (3)	Spain
National	V	V	S	V	V	V	S	S	S	V	S	V
International	-	S	S	V	V	V	S	S	S	S	S	-
European	-	-	S	S	S	S	S	S	S	V	S	-
US	-	-	-	S	S	V	-	-	-	-	-	-

Table 6-2: Sources of guidance currently used by PTOs / IMs

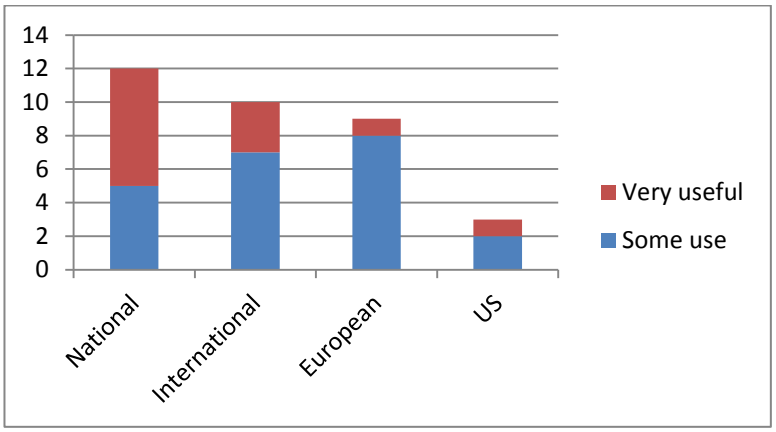

Figure 6-2: Sources of guidance currently used by PTOs / IMs

Summaries of results from the different countries are presented below:

UK: Three responses were received from the UK (two IMs and one PTO). One IM considered UK national guidelines 'very useful' but didn't use any other sources of guidance. The other IM used guidance and standards for all the activities listed and found national guidelines very useful and international and other guidelines of some use (specifically ISO and BSI standards). The PTO used guidance for all activities and used national, international and European guidance.

Spain: The Spanish national PTO used only national guidelines (e.g. CNPIC). The respondent did not answer the other questions.

Italy: Two PTOs (one metro and one mainline) responded from Italy. One currently used guidelines for carrying out risk assessment and found national, US and International guidelines to be 'very useful' and European and other guidelines to be 'some use'. The other PTO used guidelines for deciding design criteria, designing and re-designing new and existing infrastructure and for developing security protocol. They found National, European and International guidelines to be 'some use'.

Romania: Decision makers from an underground transport operator, passenger rail transport operator and the Romanian transport ministry were interviewed using the SECURESTATION questionnaire. In order to address security issues the Romanian stakeholders referred to national, European and International guidelines and standards.

Denmark: A Metro Operator responded from Denmark. This PTO used guidelines for all activities listed with national and international guidelines cited as 'very useful' and European and US guidelines as 'some use'. Specifically they used various EN regulations (126, 128, 129), ISO 9001, NFPA 130 (USA) and CENELEC EN45545.

Portugal: A Metro Operator responded from Portugal. They used guidance for most of the activities listed with national and international guidelines considered 'very useful' and European and US guidelines 'some use'. Specifically they used NFPA 130, various EN regulations, 'Decreto-Lei No.220/2008' (national guideline) and technical notes of the Portuguese civil protection authority.

Germany: Three German PTOs responded to the survey. All three used National, European and International guidelines and one also found US guidelines to be very useful. One respondent specifically mentioned using OECD guidelines on security information systems networks, DIN EN 50132-7:2013-04 standard on CCTV surveillance systems and German standard 'mindeststandard des BSI nach 8Abs 1 Satz 1 BSIG' as well as others.

Finally, operators were presented with a list of 33 station security issues and were asked if they agreed with any of the following responses: 'Existing guidance is sufficient'; 'Specific guidance is probably needed' and 'More guidance is welcome'. 11 of the 12 respondents answered this question. The values correspond to the number of respondents who agreed with the statement for each issue in the list. Table 6-3 shows the results for risk assessment guidance and Table 6-4 for design guidance.

Specific risk assessment guidance	Existing guidance is sufficient	Specific guidance probably needed	More guidance welcome
Security risk assessment	2	4	5
Fire risk assessment	1	2	3
Terrorism risk assessment	5	6	8

Table 6-3: PTO / IM opinion on current risk assessment guidance

Security issue / area	Existing guidance is sufficient	Specific guidance probably needed	More guidance welcome
CCTV	2	3	4
Video analytics	4	6	8
Design for personal safety (e.g. open-plan layout, lighting.)	1	4	4
Normal lighting	1	1	1
Emergency lighting	1	1	1
Fire prevention and mitigation design	0	2	2
Fire detection	1	1	2
Fire extinguishing equipment	0	2	2
Structural resilience to fire damage	0	1	1
CBRN detection & mitigation	3	6	7
Mitigation of toxic substance dispersion (ventilation)	1	6	7
Cyber-crime prevention	5	6	8
Dealing with suspicious packages	1	3	3
Planted IED & IID prevention, detection & mitigation	5	6	8
Carried IEDs prevention, detection & mitigation	5	5	7
VBIED mitigation (e.g. vehicle barriers)	5	2	5
Explosive material detection	4	5	6
Design for explosion mitigation (shock wave and shrapnel minimisation)	4	4	6
Structural resilience to explosions	4	4	7
Explosion resistant security glazing	4	2	5
Passenger screening	4	6	8
Armed attack (mitigation and evacuation)	2	4	5
Emergency evacuation procedures	1	1	1
Station design for emergency evacuation	0	3	3
Emergency exits	2	2	2
Design of public areas (e.g. waiting room)	0	3	3
Site design for security (e.g. perimeter security, layers of defence)	2	3	4
Avoiding panic in emergency situations	4	8	9
Rail infrastructure sabotage prevention	5	6	8
Emergency response/ training	3	4	4

Table 6-4: PTO / IM opinion on current security design guidance

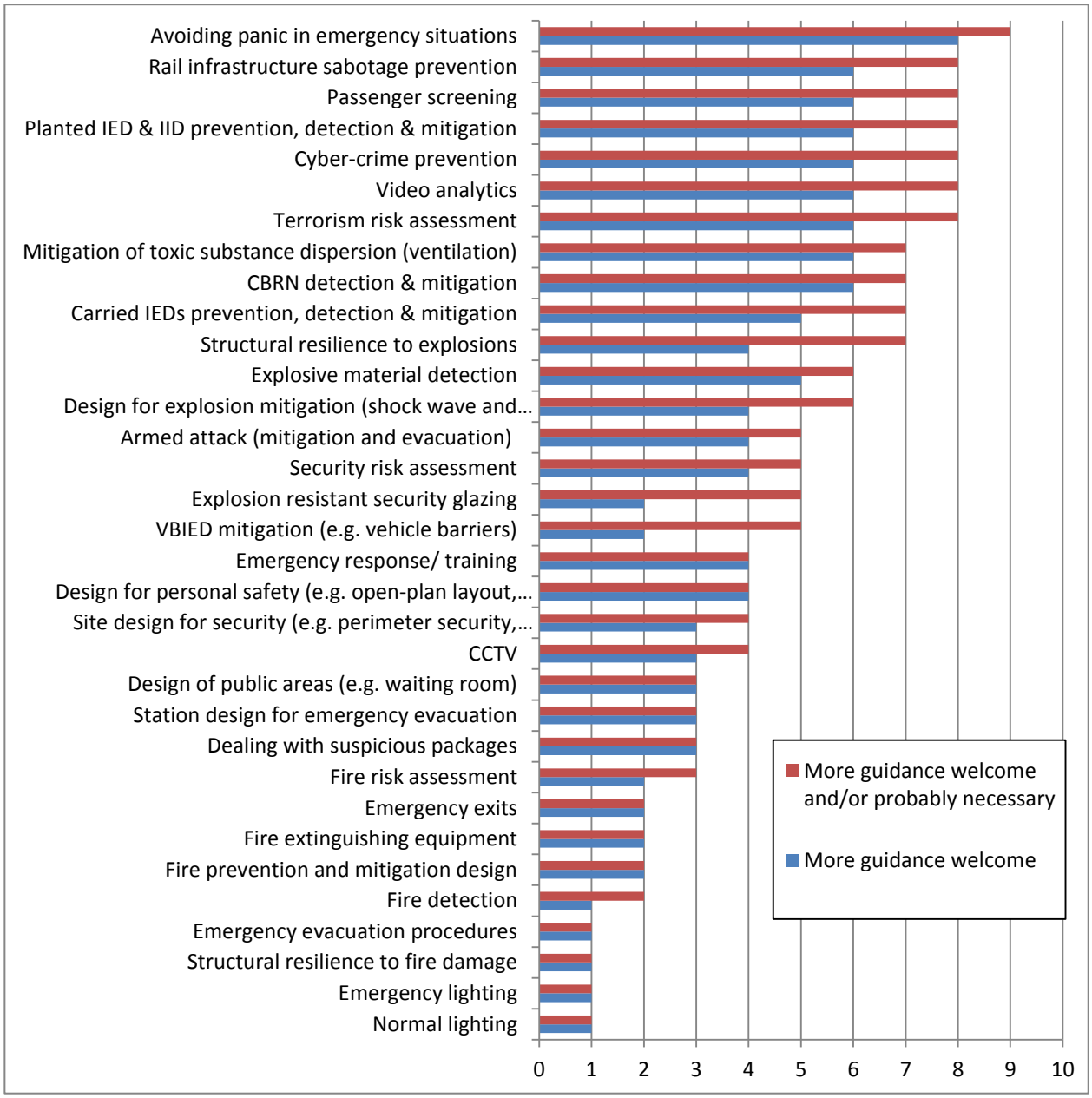

Figure 6-3 Issues on which IMs / PTOs want more guidance

Regarding existing guidance on risk assessment, the majority felt that this was sufficient in the context of fire but that more guidance on security and terrorism risk assessment would be welcome (Table 6-3). Table 6-4 shows all the other security issues and whether existing guidance was sufficient or more was needed. Figure 6-3 presents the issues for which more guidance was 'welcome' and/or 'probably necessary' in ranked order. The only issue for which all respondents to this question said they would welcome more guidance or that it was probably necessary was on '*Avoiding panic in emergency situations*'. There seemed to generally be less of a call for more guidance on lighting and on the issues closely related to fire risk (possibly as this is a more common and well-established safety issue for which a lot of guidance already exists).

7. Gap analysis summary and conclusions

The gap here can be considered as either the gap between the outputs of the SECURESTATION project and the existing guidance available or the gap between the guidance that PTOs and IMs currently use and the guidance they would like to have. There is clearly another gap: the gap between what is available and what operators are aware of, have access to and actually use. As has been shown in this report, there is a large amount of information available, some of which is very relevant to European Rail PTOs and IMs, some of which is addressing the relevant threats and some of which is very detailed. There are two possible reasons why the available resources are not fully exploited: Firstly, a lot of the high quality public domain guidance studied for this report is produced by and for the UK or USA. Although much of the guidance is transferrable to other European nations, there may be either a reluctance to use foreign national guidelines for such a sensitive area or simply a language barrier. Secondly, some of the guidance has an emphasis on specific contexts (such as high rise buildings in the case of the NYPD guidelines on building design) which are less relevant to rail infrastructure. Alternatively they may be more general (aimed at the broad context of 'crowded places' for example) and therefore contain less specific information relevant to stations etc. Therefore, for a PTO to gain all the necessary and relevant information would require a certain degree of research, sifting out what is applicable and what is not and applying some engineering guidance to contexts for which they were not intended.

These issues can be addressed to some degree in the SECURESTATION outputs by focussing the RAM and Constructive Design Handbook on relevant issues in sufficient detail and writing in the context of European rail passenger stations, terminals and interchanges. Also, there may be more confidence in using a RAM tool and Design handbook which has been produced by EU engineers, architects and PTOs. Some of the results of WP 5 and 6, particularly from the chemical dispersion modelling and equipment vulnerability modelling, have been used to inform the design guidance and all of the modelling work has contributed to the body of knowledge generally in this area, as described in Chapter 5.

According to the survey, European PTOs and IMs use guidelines and standards to varying degrees for security related activities. There was a strong bias towards national guidelines and standards followed by international and European guidelines whereas very few use guidelines on risk assessment or design for security from the USA.

The responses to the list of security related issues varied greatly between respondents. The total number of issues for which each respondent either welcomed more guidance or thought more guidance was probably necessary ranged between 5 and 27. Most importantly, for several of the security-related issues listed in the questionnaire that are being addressed within SECURESTATION, over half the respondents said that they would welcome more guidance (Figure 6-3).

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This project has been carried out under a contract awarded by the European Commission